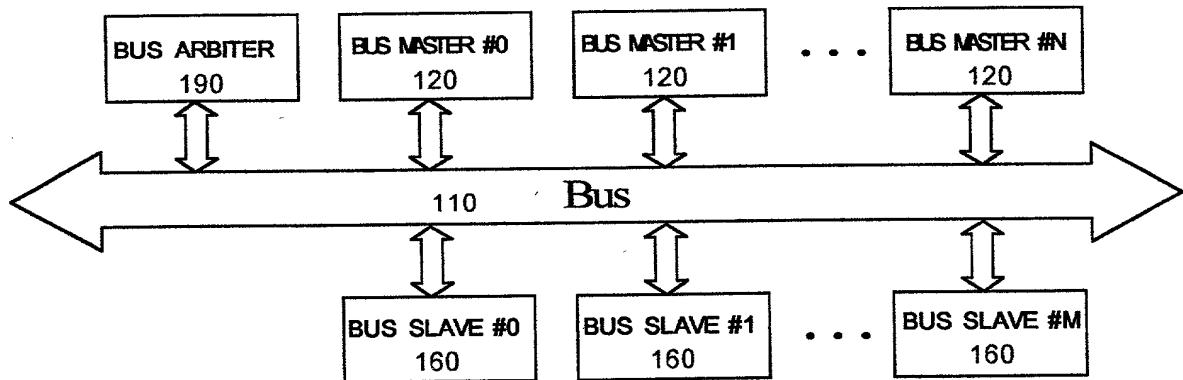


FIG.1 (PRIOR ART)

100



## FIG.2 (PRIOR ART)

200

205

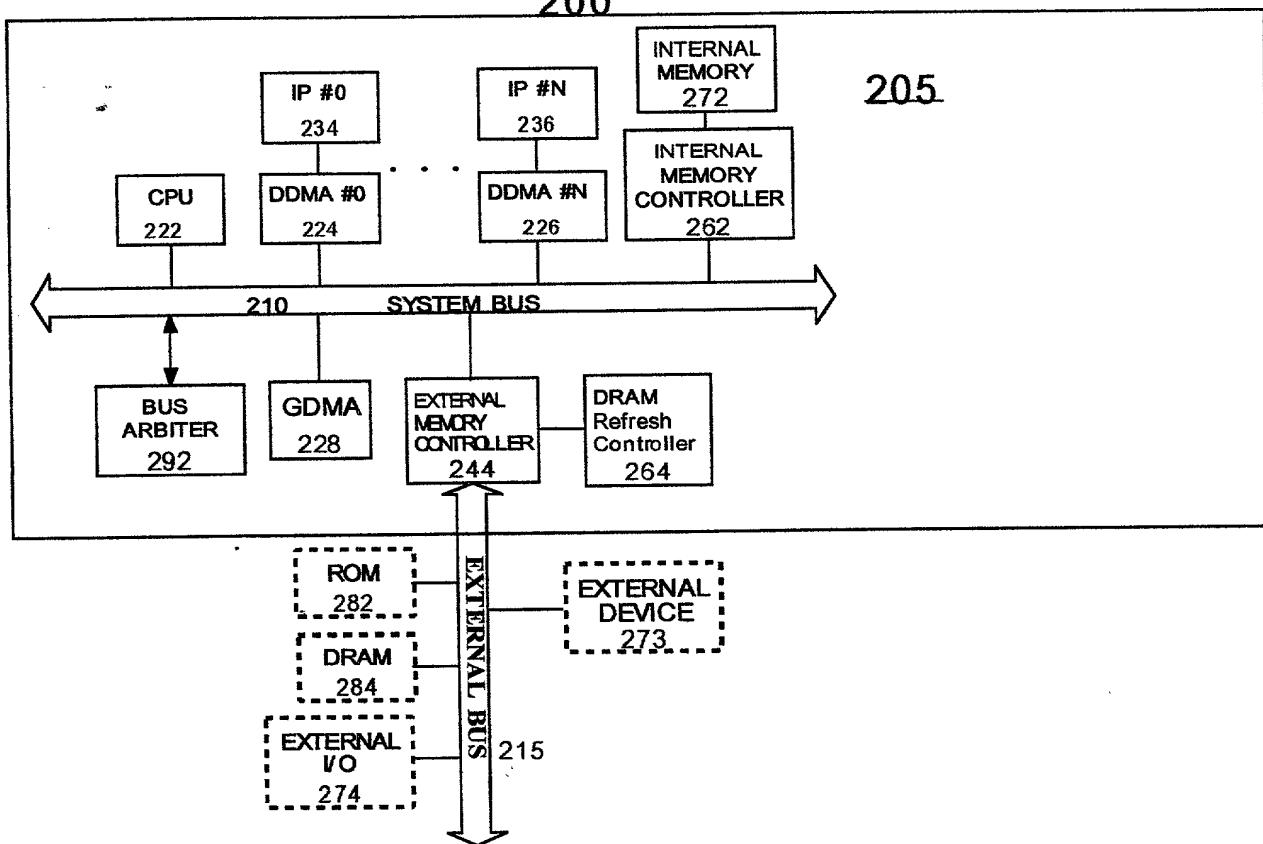


FIG.2B (PRIOR ART)

292

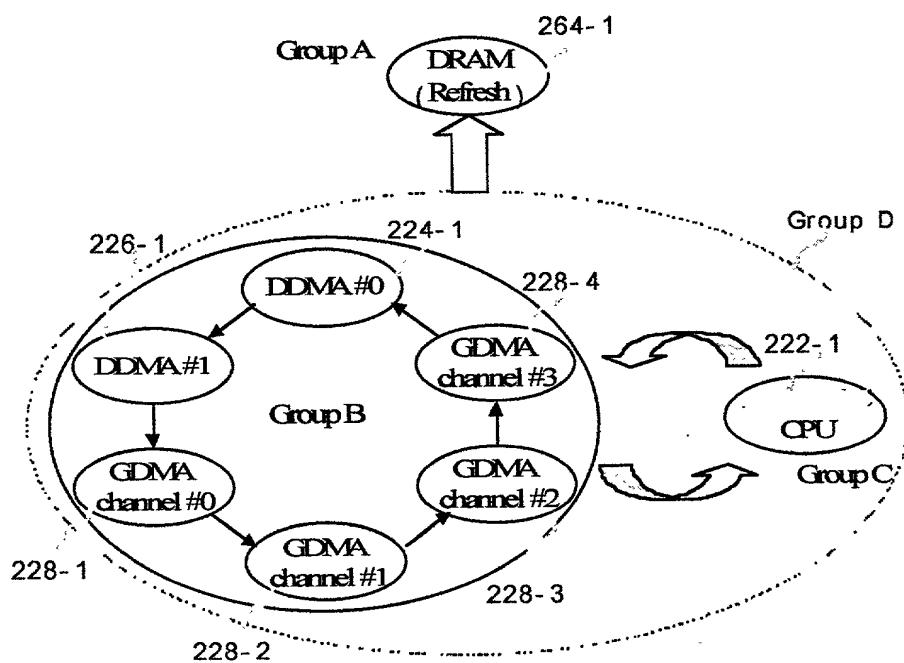


FIG.2C (PRIOR ART)

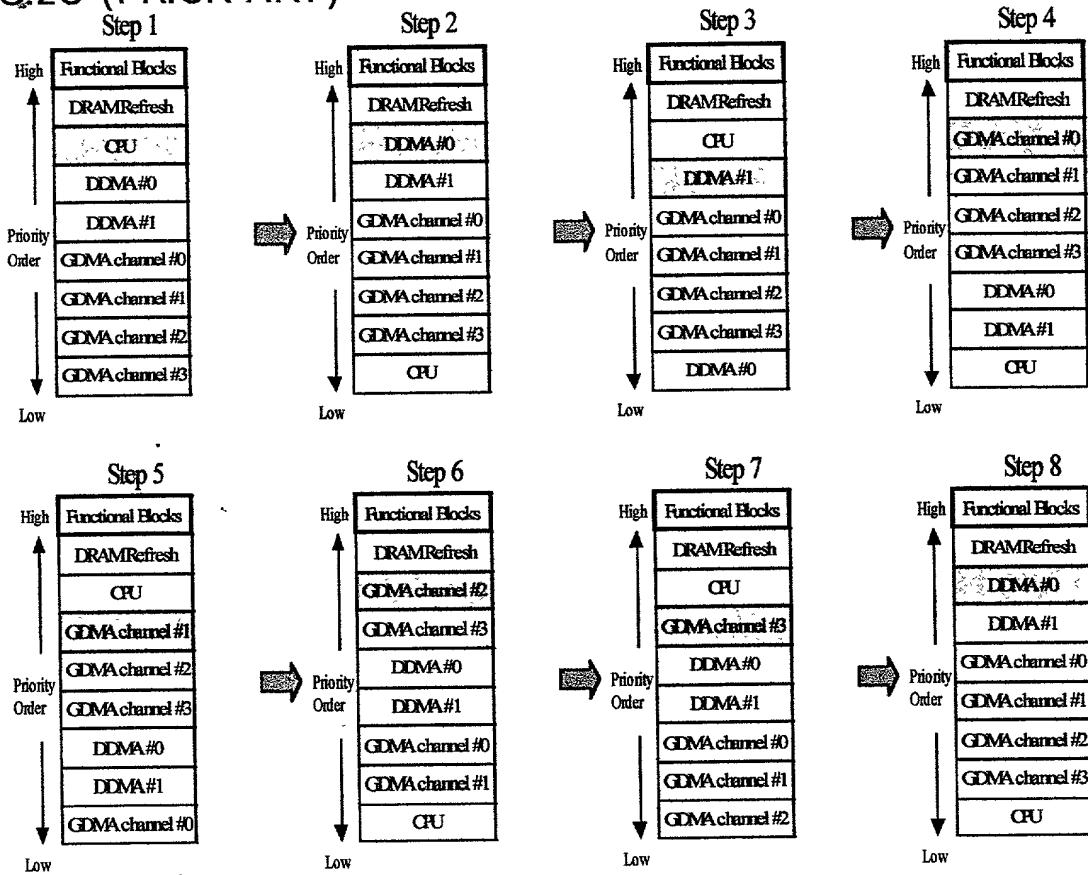
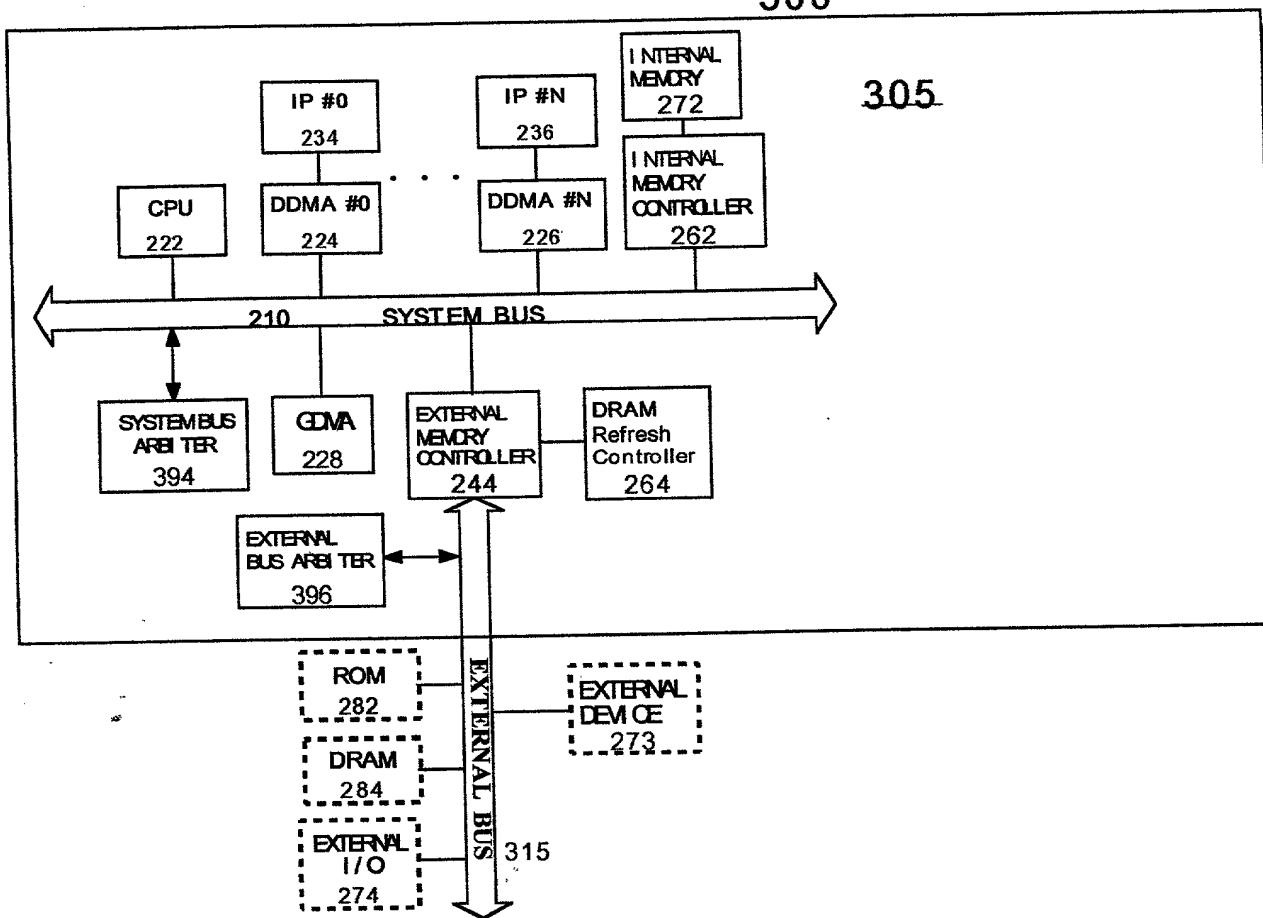


FIG.3A (PRIOR ART)

300

305



00101100 01111010 01100001 01100000 01100001 01100000 01100001 01100000

FIG.3B (PRIOR ART)

394

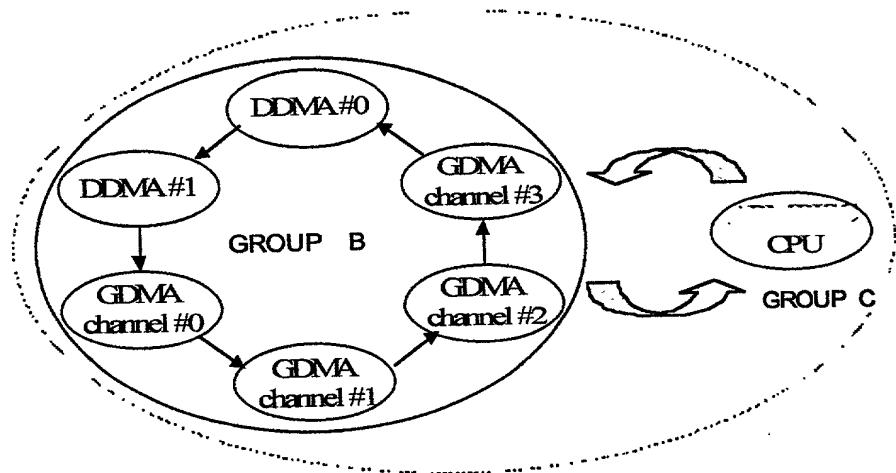


FIG.3C (PRIOR ART)

396

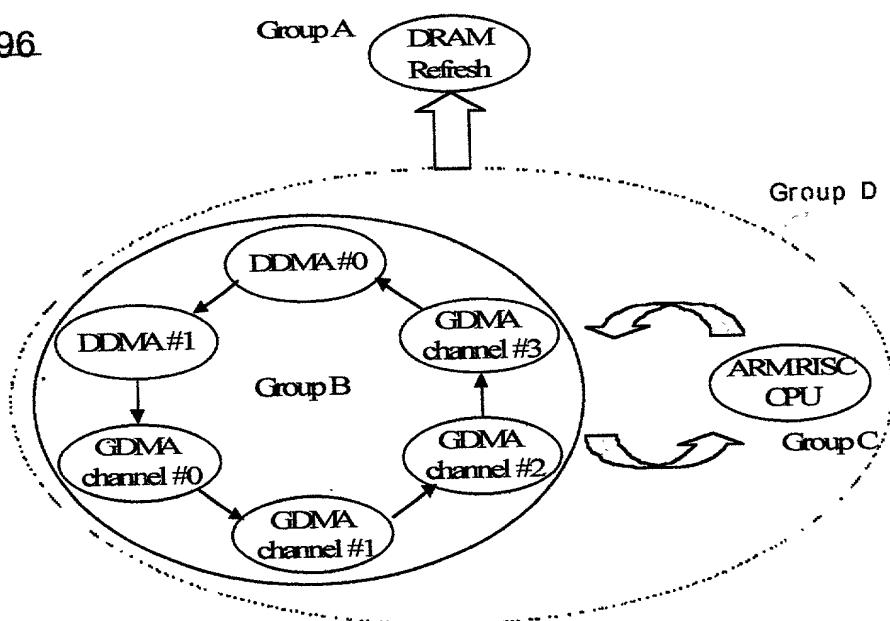


FIG.3D (PRIOR ART)

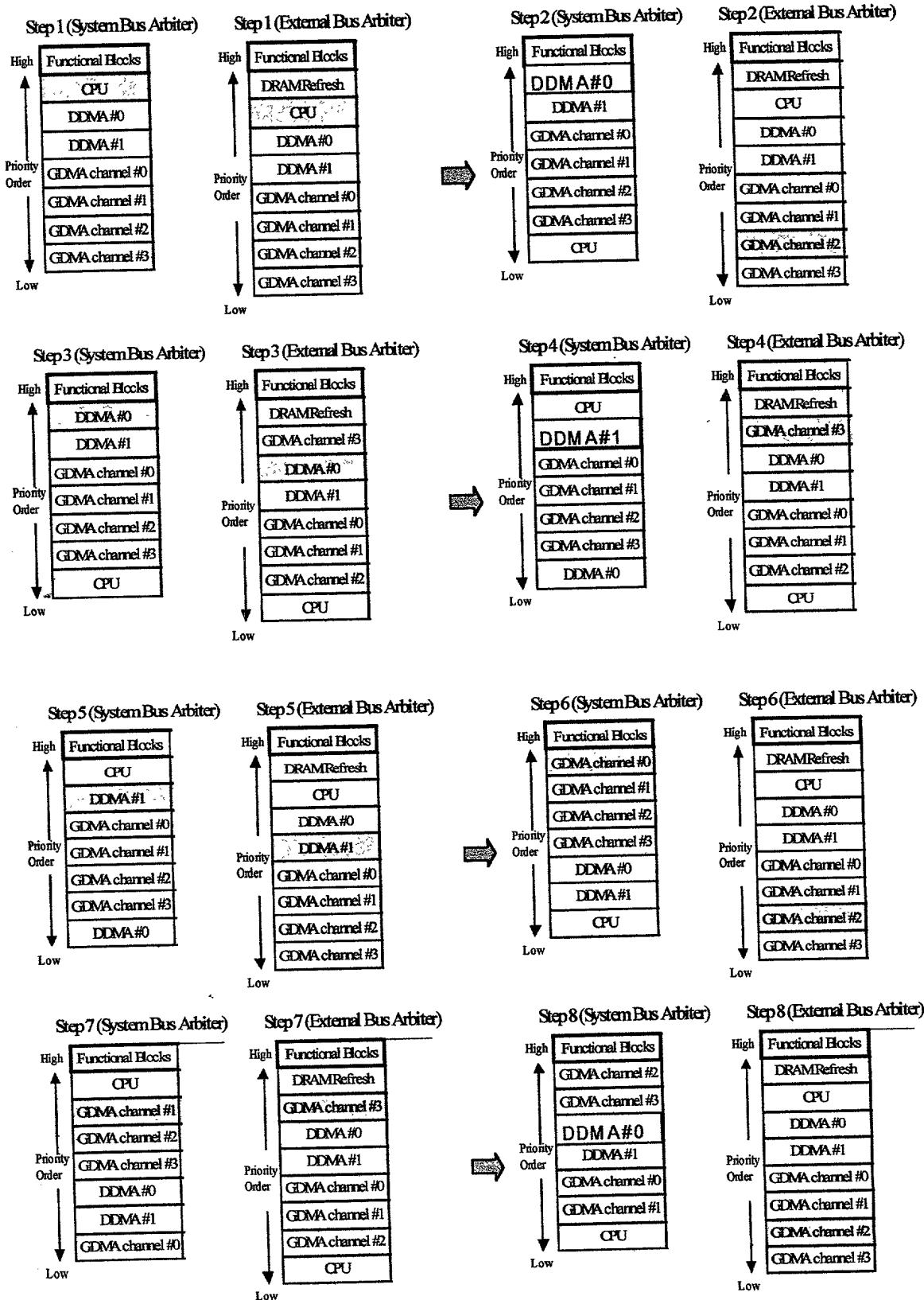
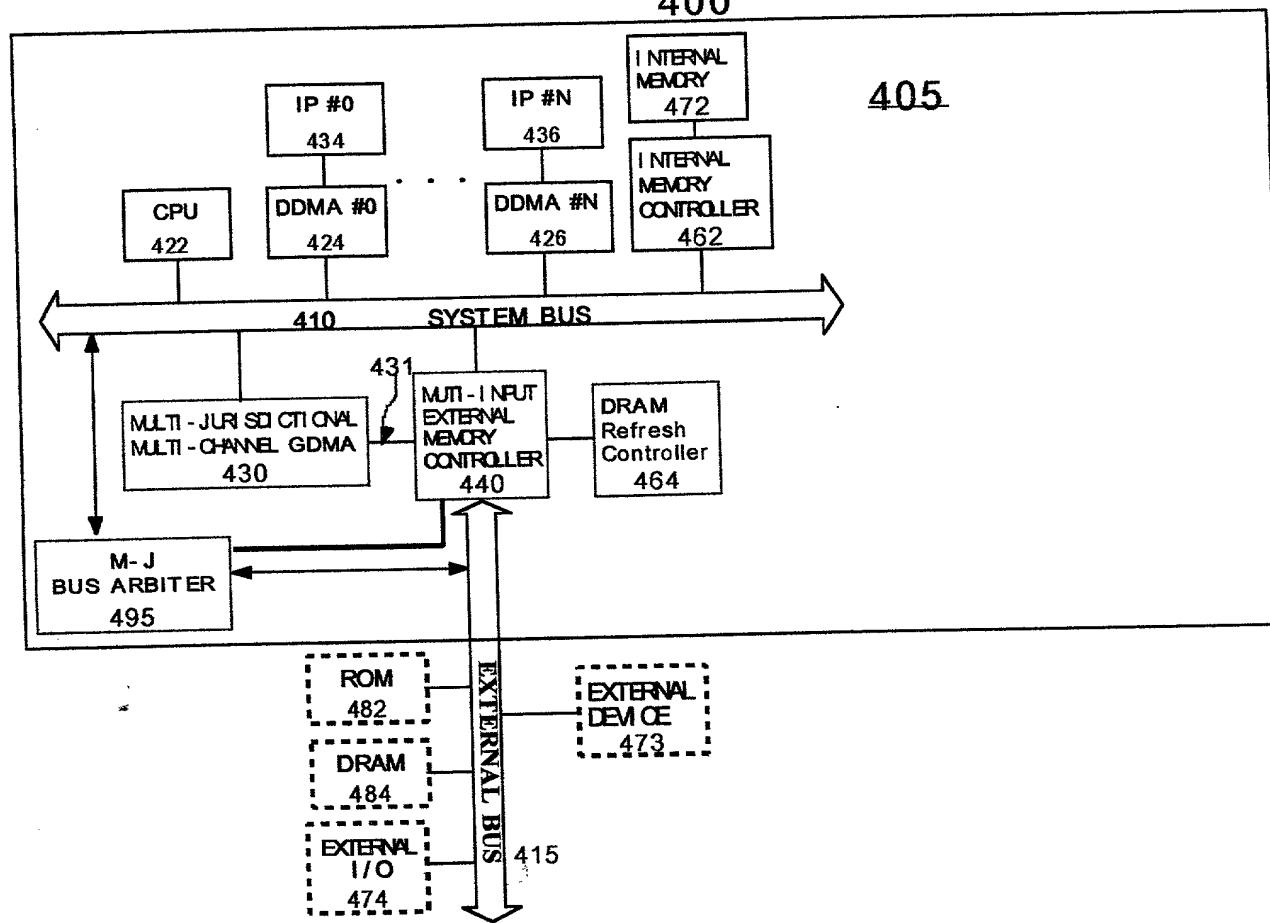


FIG.4

400



405

FIG.5

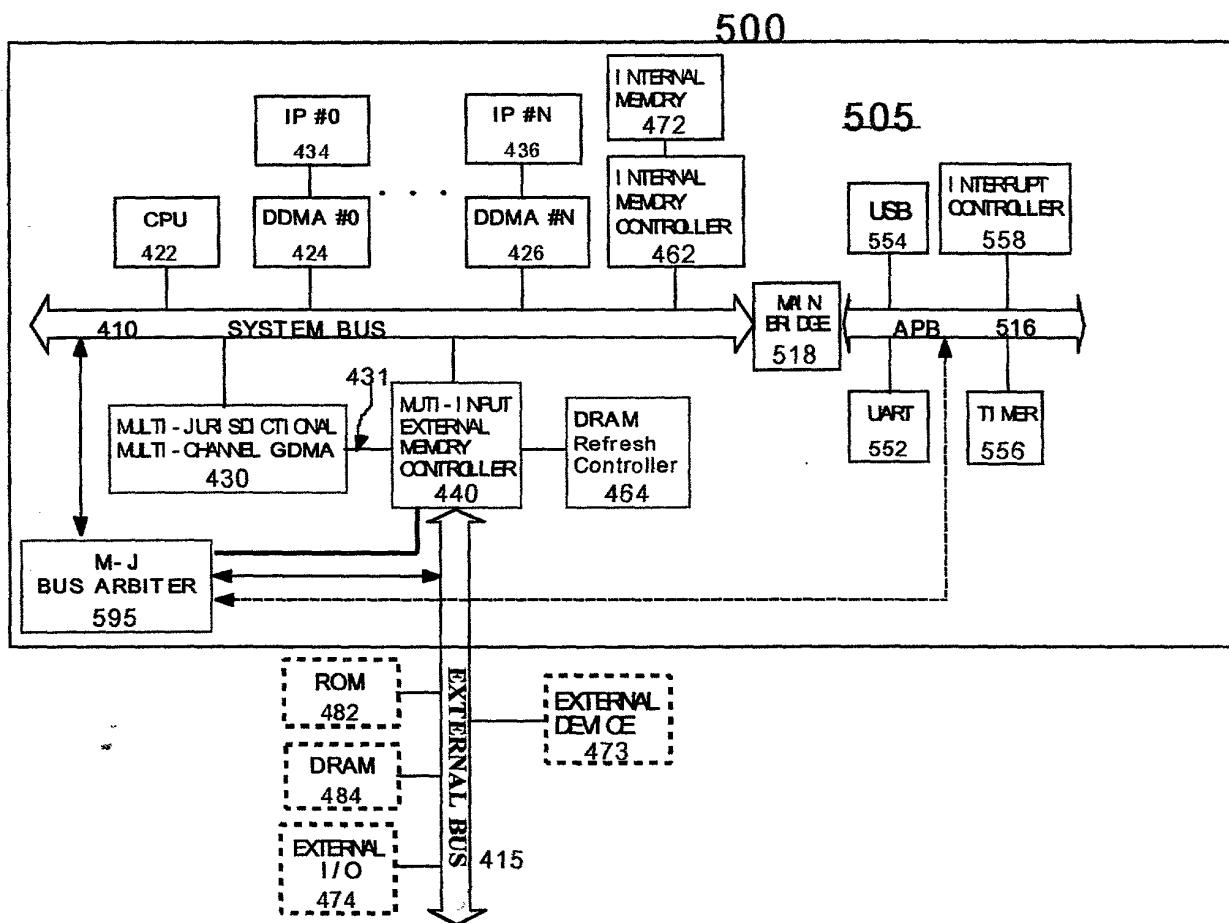


FIG.6

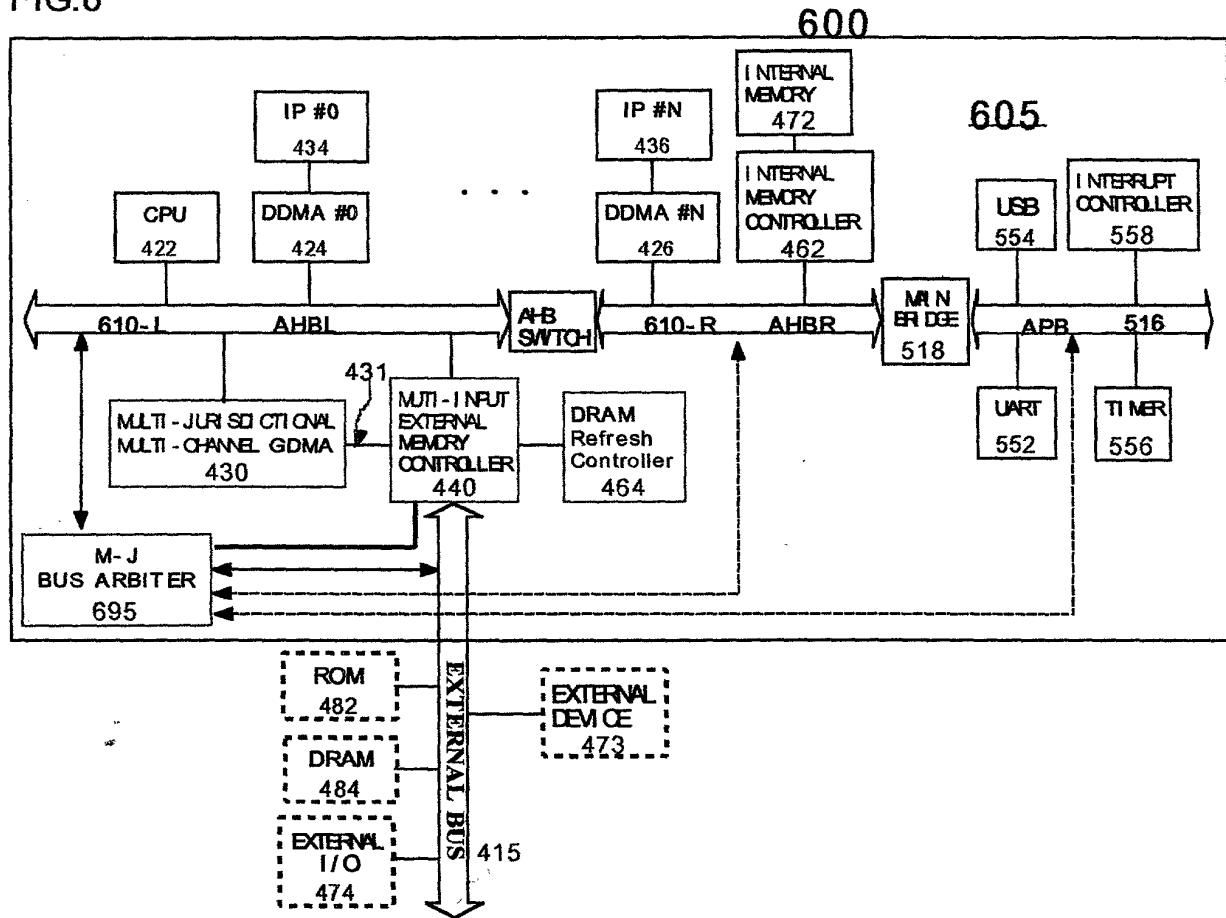


FIG.7

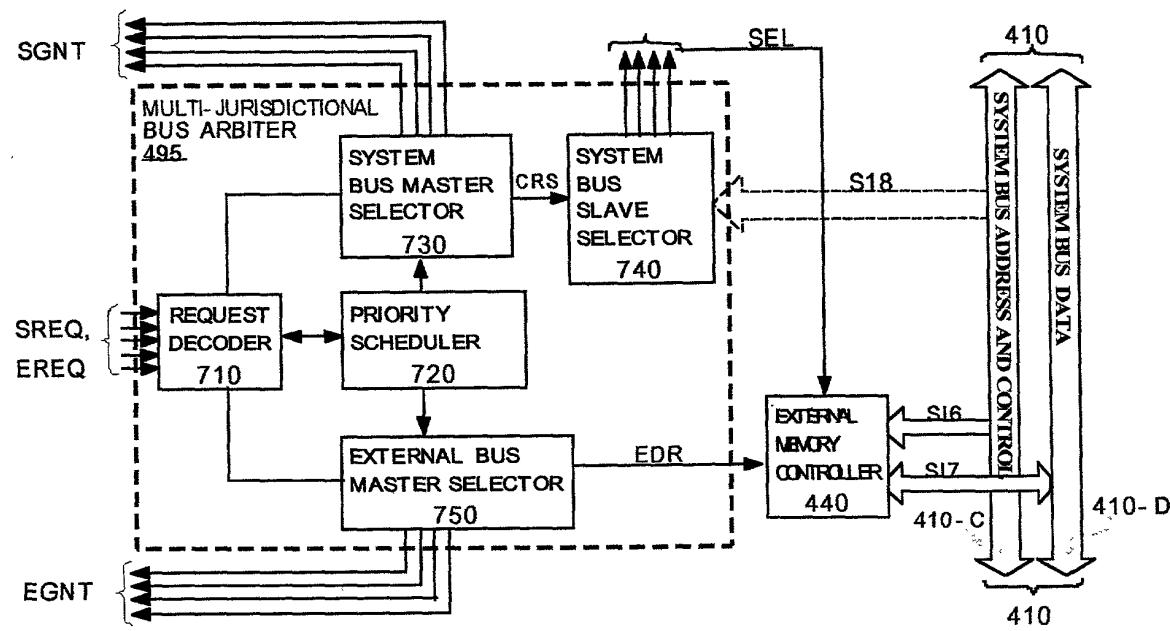


FIG.8

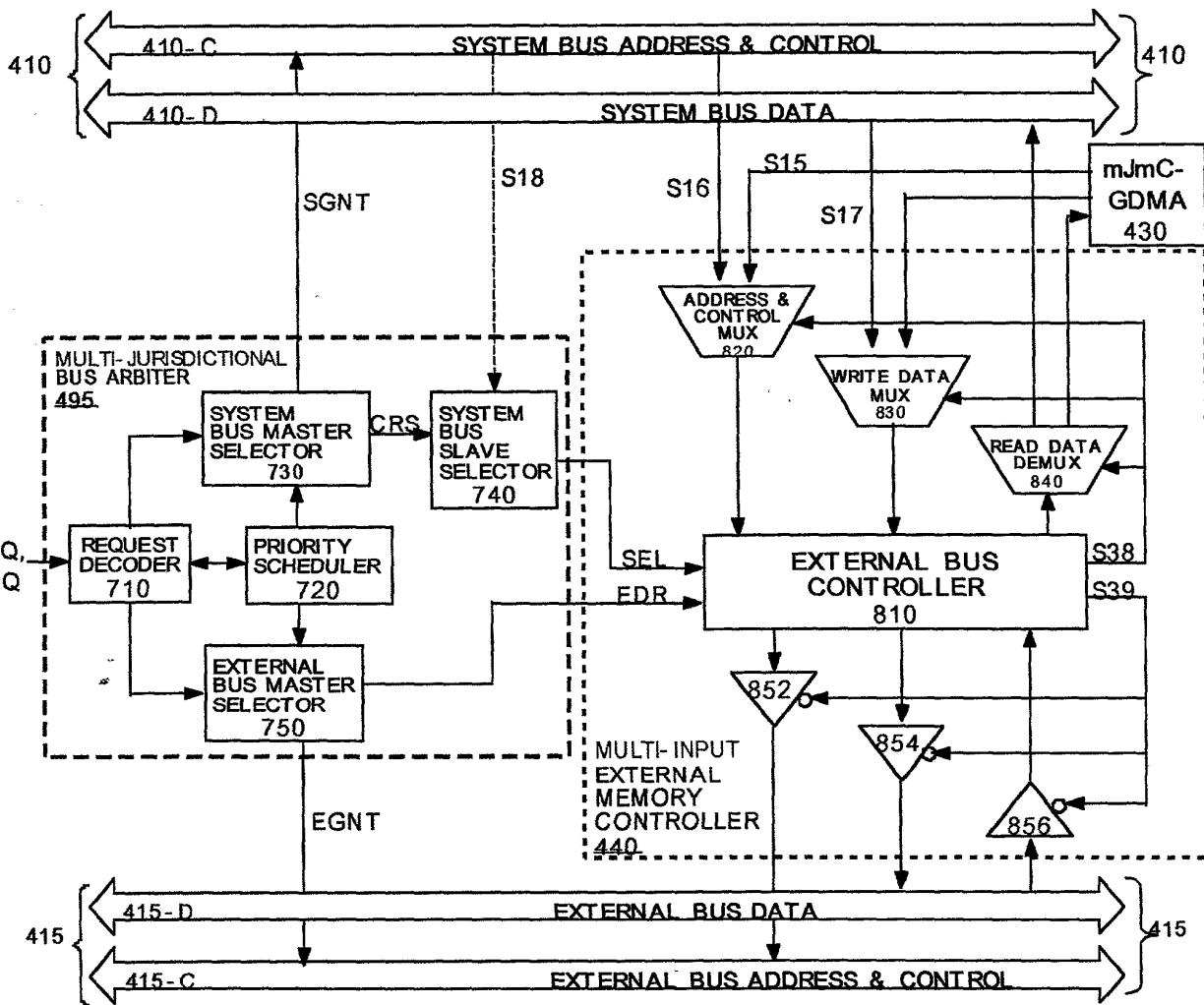


FIG.9

		External bus master	System bus master	
	No request REQ[1:0] = 2' b00	External bus only REQ[1:0] = 2' b10	System bus only REQ[1:0] = 2' b01	Both buses REQ[1:0] = 2' b11
DRAM refresh controller	O	O	X	X
CPU	O	X	O	O
DDMA block	O	X	O	O
DDMA channel	O	O	O	O
External device	O	O	X	X

FIG.11

Classification of set	Element
Set of functional blocks making a system bus request (system bus master, S)	CPU, DDMA block, and DDMA channel
Set of functional blocks making an external bus request (E)	DRAM refresh controller, CPU DDMA block, DDMA channel, and external device
Set of functional blocks making only a system bus request (SO)	CPU
Set of functional blocks making only an external bus request (EO)	DRAM refresh controller, DDMA channel, and external device
Set of functional blocks making a request for both system bus and external bus (ES)	CPU, DDMA block, and DDMA channel
Set of functional blocks making requests for a system bus or an external bus (A)	DRAM refresh controller, CPU DDMA block, DDMA channel, and external device

FIG.10

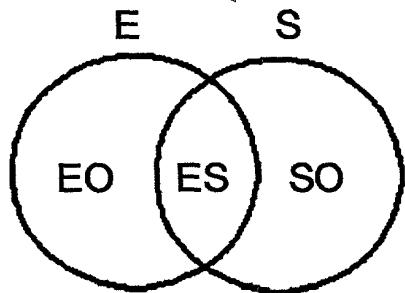


FIG.12

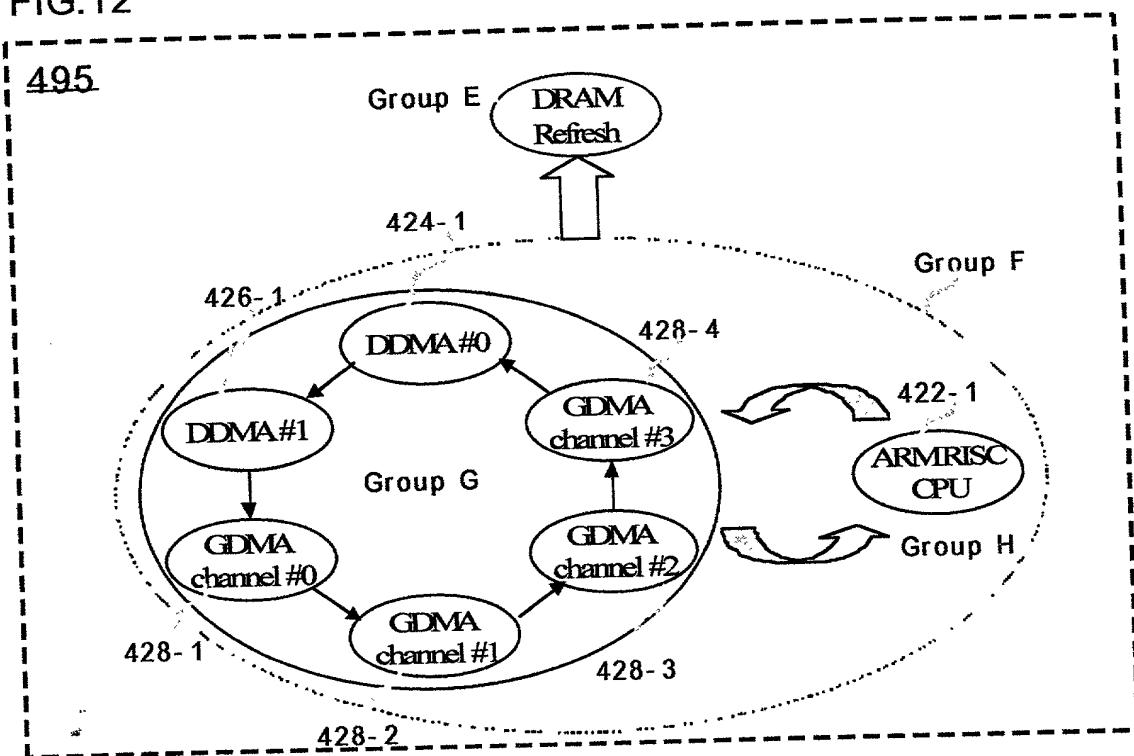


FIG.13

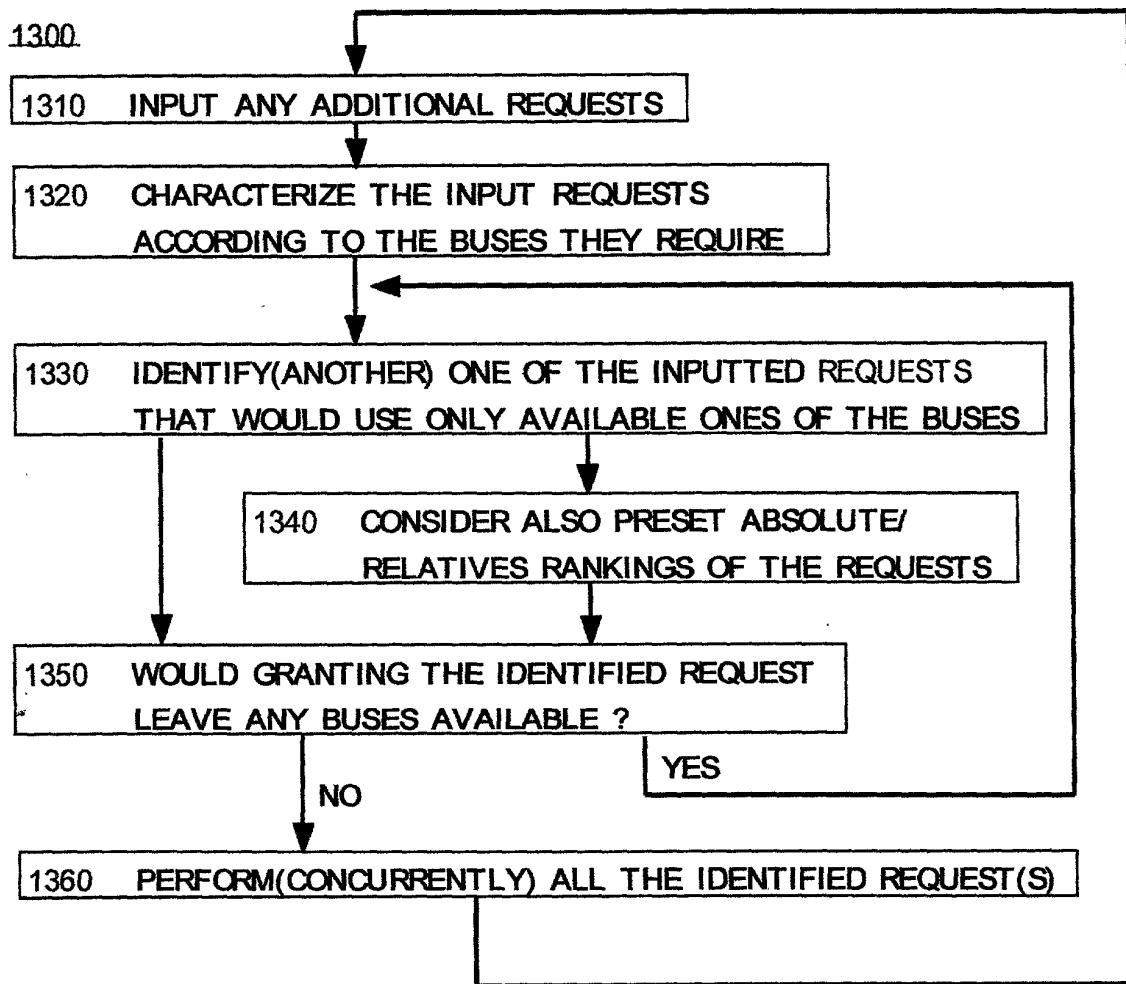


FIG.14

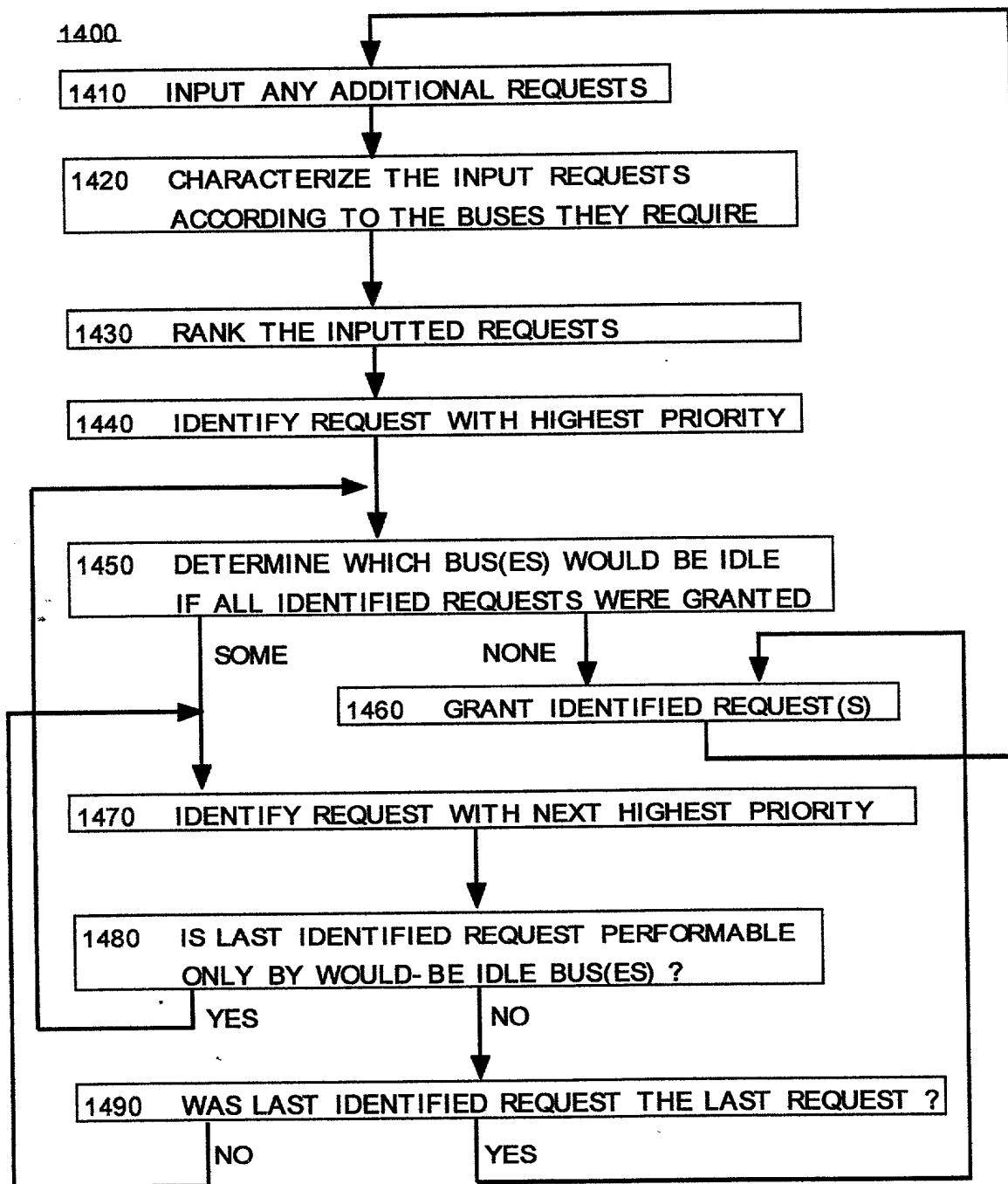


FIG.15

1500.

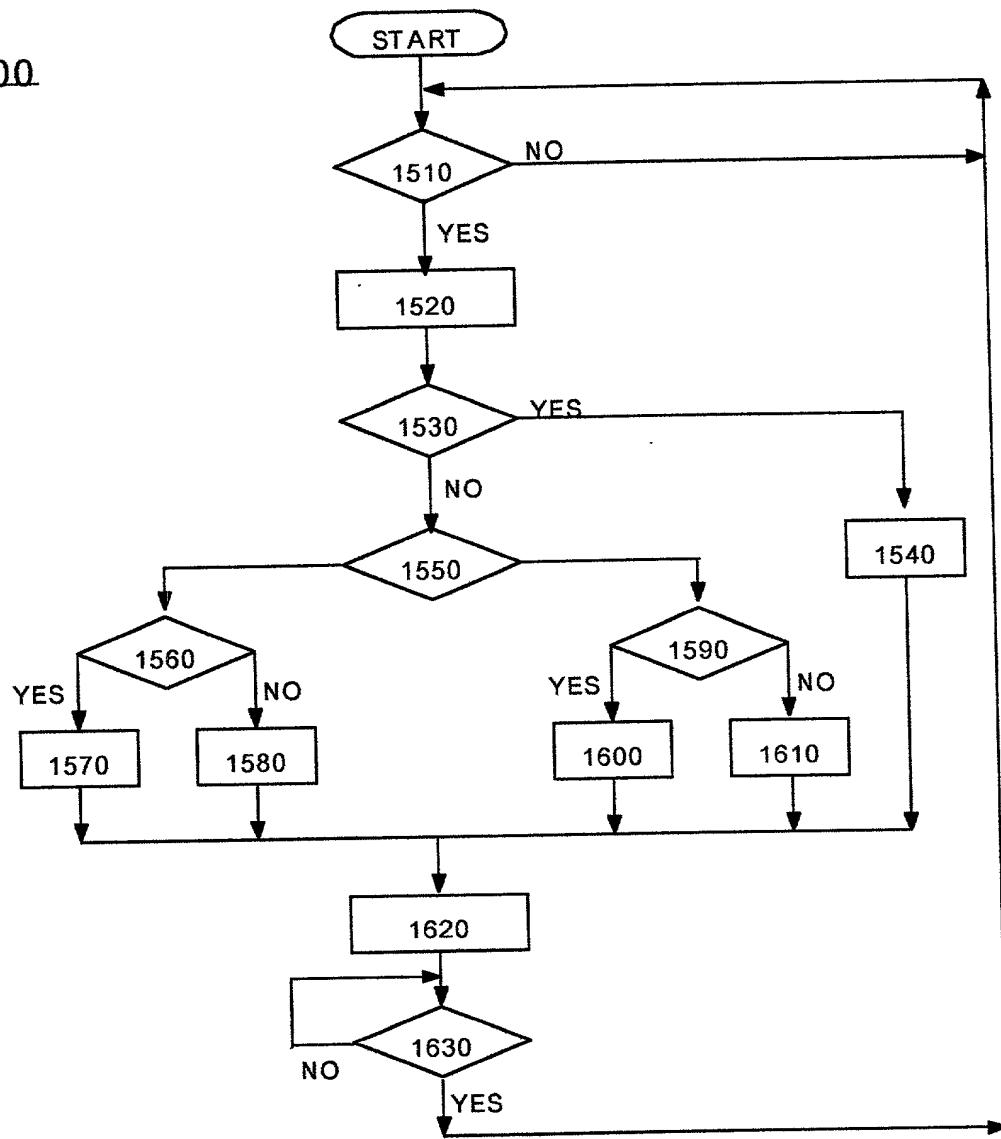


FIG.16

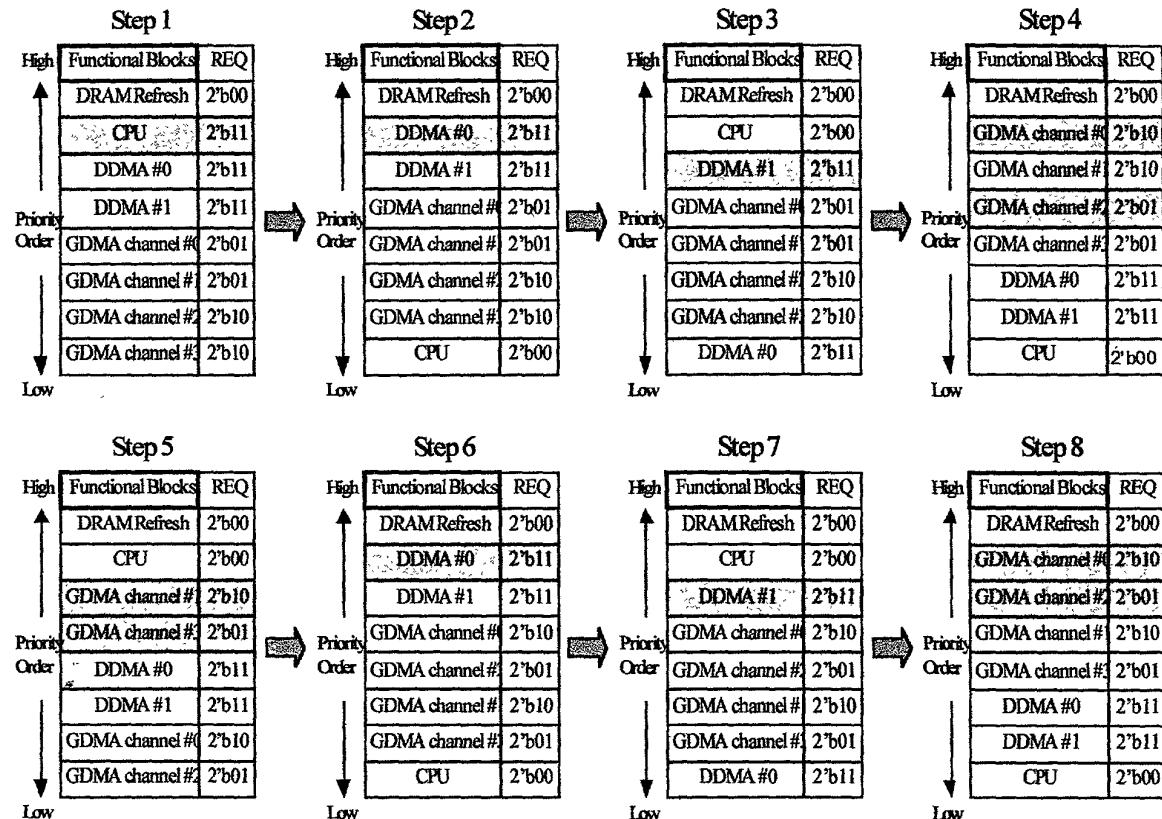


FIG.17

Item	Probability that element having bus ownership performs operation			Bus utilization
	Element of set EO	Element of set ES	Element of set SO	
Exclusive bus arbitration	$\frac{1}{n(A)}$	$\frac{1}{n(A)}$	$\frac{1}{n(A)}$	$\frac{n(EO) + 2n(EO) + n(SO)}{2n(A)}$
Hierarchical bus arbitration	$\frac{n(ES) + 2n(SO)}{2n(S)n(EO)}$	$\frac{1}{2n(S)}$	$\frac{1}{n(S)}$	$\frac{4n(SO) + 3n(ES)}{4n(S)}$
Present invention	$\frac{n(EO) + n(SO)}{n(A)n(EO)}$	$\frac{1}{n(A)}$	$\frac{n(EO) + n(SO)}{n(A)n(SO)}$	1